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Self-supporting Honeycomb Structure from Flexible Film Strips and Process for Manufacturing Same

The present invention pertains to a honeycomb structure from flexible material strips, which are connected to one another, so that a self-supporting honeycomb structure is formed, as well as to a process for manufacturing same.

Corresponding honeycomb structures are used, among other things, as transparent or opaque heat insulation, as filler material for partitions or as the core material in the manufacture of sandwich boards.

If the honeycombs are used as heat insulation, low density is important in order to obtain good insulation values. If the honeycombs shall be used for sandwich boards, high compressive strength combined with high shear strength shear strength is necessary.

Similar honeycomb structures are described in the Auslegeschrift DT 2231959 B2 and in the Offenlegungsschrift DE 197 03 961 A1.

The Auslegeschrift DT 2231959 B2 describes a honeycomb from corrugated, rigid strips, which have an inherent stability, so that they can be stacked up on one another, and form a self-supporting structure, without the strips being welded or bonded to one another. The prerequisite for this is that the arches of the corrugations have such an arrangement that the shortest free distance between two adjacent peaks of the corrugation in each strip is smaller than the greatest free width of the valley of the corrugation (therefore, the corrugated strips cannot be pushed into one another).

Honeycombs of this type cannot be manufactured from flexible material strips, because a flexible strip cannot be bent into a rigid corrugated shape.

Honeycombs of this type are used as the core for sandwich boards made of metal, e.g., in the manufacture of aircraft.

A honeycomb structure made of flexible film strips is described in the Offenlegungsschrift DE 197 03 961 A1, wherein the film strips are welded onto one another in the corrugated form, so that a self-supporting honeycomb is formed. The principal difference from DT 2231959 B2 is that flexible strips are used here and a honeycomb is generated only when the strips are connected to one another by welding or bonding in the transition area from the horizontal and vertical partial areas of the corrugated strips arranged one on top of another. The residual stress (restoring behavior) of the flexible strips ensures that the honeycomb is more rigid and stable than a honeycomb made of pre-corrugated webs. A honeycomb is formed which is similarly bulged as the honeycomb from DT 2231959 B2 and has a nearly isotropic behavior whether it is loaded mechanically in the vertical or horizontal direction. One drawback is that this honeycomb cannot be compressed without distortions developing in the structure. Another drawback of this honeycomb which is linked with the process is the optically nonuniform edge structure. Since individual film strips are welded to one another, the overhanging film strips overlap at the lateral edges in parallel to the direction of production. To obtain a clean edge closure, an edge strip must be cut off, as a result of which drawbacks arise in terms of costs due to clipping.

The basic object of the present invention is to improve a honeycomb of the type mentioned in the introduction such that a self-supporting honeycomb is formed from flexible strips, which has a clean edge structure and can be compressed in a direction in parallel to the direction of

production.

This object is accomplished according to the present invention in a honeycomb according to claim 1 by a self-supporting honeycomb being manufactured from flexible strips, which honeycomb consists, however, contrary to DE 197 03 961 A1, of horizontal, bent partial areas arranged at right angles to one another in parallel to the direction of production and straight vertical partial areas.

In addition, the bonded or weld seam of the honeycomb being described here consists of straight, vertical partial areas rather than of the horizontal and vertical partial areas of the corrugated strips arranged one on top of another (or in other words, at the edges of the parallelepipedic cavities), as in DE 197 03 961.

These features, which are essential for the present invention, are characteristic of a compressible honeycomb, and the advantage is above all that a compressed honeycomb can be transported at a substantially lower cost. Moreover, there are applications, e.g., as heat insulation, which require a small hole diameter, which can be obtained simply by compressing the honeycomb. Minimization of the hole diameter means a maximization of the heat insulation factor (k value) for a honeycomb.

The honeycomb displays different behaviors under mechanical loading in the horizontal and vertical directions. Compression in parallel to the direction of production is possible without the structure of the honeycomb being distorted. A clean edge is formed on both sides of the honeycomb along the direction of production, because the respective outer film is welded endlessly to the honeycomb.

The device with the process steps, with which a self-supporting honeycomb structure according to the present invention with the features of claim 1 can be manufactured, is disclosed in claim 5.

The device has a welding head, which comprises a plurality of welding sections or webs arranged in parallel to and at uniformly spaced locations from one another, all of which are equipped with a welding wire on the front side. Flat slide elements, which can be displaced forward and backward in parallel to the webs, are in contact with the lateral surfaces of the welding webs.There is a small gap between the slide elements, through which the film strips can be guided. In addition, the device has a comb with individual fingers, which can be moved into and withdrawn from the honeycomb structure in front of the welding webs. The welding head and the finger comb are displaceable in parallel to one another.

In addition, the welding head and the finger comb can be pressed against one another.

The necessary U-shaped corrugated structure of the film strips is produced with the device by the lateral displacement of the welding head and the comb, and the film strips are subsequently welded to one another at the vertical partial areas.

Not only plastic films, but all types of flexible material strips can be connected to one another with the device, the only requirement being the weldability of the material.

The honeycomb structure according to the present invention as well as the process steps for manufacturing this honeycomb structure will be explained in greater detail below on the basis of the drawings attached. In the drawings,

Figure 1 shows a top view of a honeycomb structure according to the present invention.

The connection of the individual film webs to the points designated by (4) is possible by bonding or, as was described above, by preparing a weld seam extending at right angles to the film web.

Figures 2-8 show a top view of the device for manufacturing the honeycomb structure according to Figure 1 with the individual process steps.

The device with the individual process steps, by means of which the honeycomb structure according to the present invention can be manufactured from film webs by using welded connections, will be described below as an example.

Figure 2 shows the welding head with the welding webs (6), which are equipped with welding wires (7) on the front side, and with the flat feed elements (8), which are in contact with the welding webs.

The welding head is located in the starting position, and the individual film strips (9) are inserted between the narrow gaps of the feed elements.

Figure 3 shows the first process step. The feed elements (8) move forward until they project from the welding head over a certain distance. The finger comb (10) now moves between the feed elements and thus into the film strip until it stands in front of the welding head over the full welding height.

The feed elements (8) move back again behind the welding plane corresponding to Figure 4.

The welding head and the finger comb (10) are now displaced in parallel horizontally by an amount corresponding to twice the distance between two welding spots. The first welding of the film takes place in this position, the welding head and the welding fingers being pressed onto one another.

According to Figure 5, the fingers (10) again move out of the film strip (9). The feed elements (8) then move forward and the film structure welded together is fed. The welding head again moves back into the starting position by an amount corresponding to twice the space between two welding spots.

The fingers (10) then move again into the film structure corresponding to Figure 6.

Figure 7 shows how the slides (8) move back behind the welding plane.

The welding head and the fingers (10) are now displaced in opposite directions. Pressing on of the welding head with the fingers (10) and the film welding operation will again take place.

The fingers (10) then move again out of the film structure according to Figure 8 and the cycle of steps begins anew with step 1 (Figure 3).